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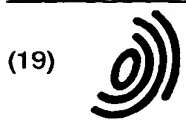
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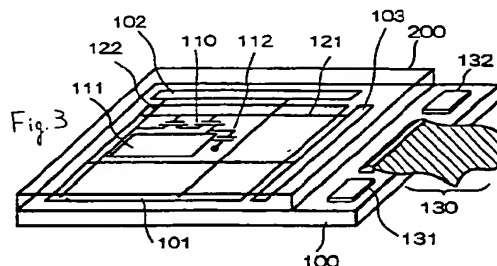
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(54) **Electronic device with liquid crystal display**

(57) An electronic device, such as personal computer, incorporating a liquid crystal panel which uses LEDs as an illuminating light source for a liquid crystal panel to reduce power consumption and size of the electronic device. When 3-color LED lamps 13R, 13G, 13B of the LED light source 12 are lit, red, green and blue rays emitted from respective LED lamps enter the scatter-plate 11 where they are scattered and mixed to produce white light LW which goes out from the entire surface of the scatterplate 11 to illuminate the entire rear surface of the transmission type liquid crystal panel 10. The white light LW that has entered the liquid crystal panel 10 is modulated according to the alignment of the liquid crystal material and passes through the color filters of the counter substrate. The user can view the transmitted light LT from the liquid crystal panel 10 as a color image.



ACTIVE MATRIX SUBSTRATE
100: GLASS SUBSTRATE
101: PIXEL MATRIX CIRCUIT
102: SCAN LINE DRIVE CIRCUIT
103: SIGNAL LINE DRIVE CIRCUIT
110: PIXEL TFT
111: PIXEL ELECTRODE
112: CAPACITOR
121: SCAN LINE
122: SIGNAL LINE
130: FPC
131: IC CHIP
132: IC CHIP
200: COUNTER SUBSTRATE

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crystal display.

Figures 4(B) to 4(D) are views for explaining a LED light source.

Figures 5(A) and 5(B) are schematic diagrams showing the arrangement of the liquid crystal panel and the LED light source.

Figures 6(A) and 6(B) are schematic diagrams showing the construction of the LED light source.

Figures 7(A) to 7(F) are external views showing examples of electronic devices.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The invention will be described by referring to Figures 1 to 7.

Embodiment 1:

[0016] This embodiment represents an example in which the present invention is applied to a note PC (personal computer) incorporating a liquid crystal display. Figure 2 shows a rough external perspective view of a note PC 20 which has a liquid crystal display 21 using a color display as a display means.

[0017] Figure 1(A) is an exploded perspective view of a main portion of the liquid crystal display 21 which has a scatterplate 11 and an LED light source 12 arranged in that order behind a transmission type liquid crystal panel 10.

[0018] As an illumination light source for the transmission type liquid crystal panel 10 an LED light source 12 is used. The LED light source 12 has LED lamps 13 arranged two dimensionally on a substrate 14. In this embodiment, as shown in Figure 1(B), LED lamps of three colors - red LED lamps 13R, green LED lamps 13G and blue lamps 13B - are used. Figure 1(B) is a partial top view of the LED lamps 13, showing the arrangement of the LED lamps 13 on the substrate 14. The three-color LED lamps 13R, 13G, 13B are arranged in delta for uniform distribution over the substrate 14.

[0019] The scatterplate 11 is made of a material transparent to a visible light, such as acrylic, polycarbonate and glass. The scatterplate 11 may be formed at its side surface with a reflection plate.

[0020] Figure 3 shows an outline construction of the transmission type liquid crystal panel 10. An active matrix substrate comprises a pixel matrix circuit 101, a scan line drive circuit 102 and a signal line drive circuit 103, all formed on a glass substrate 100. The scan line drive circuit 102 and the signal line drive circuit 103 are connected to the pixel matrix circuit 101 through scan lines 121 and signal lines 122. These drive circuits 102, 103 are formed mainly of CMOS circuits.

[0021] The scan line 121 is formed for each row of the pixel matrix circuit 101 and the signal line 122 is formed for each column of the pixel matrix circuit 101. Near the intersections of the scan lines 121 and the signal lines

122, pixel TFTs 110 connected to the scan lines 121 and the signal lines 122 are formed. The pixel TFTs 110 are each connected with a pixel electrode 111 and a capacitor 112.

[0022] An active matrix substrate and a counter substrate 200 are bonded together with a liquid crystal sealed between them. The active matrix substrate is formed with external terminals of TFTs during the manufacturing process, and the portions of the active matrix substrate that are formed with the external terminals are not opposed to the counter substrate 200. The external terminals are connected with an FPC (flexible printed circuit) 130, through which external signals and power supply are fed to the circuits 101-103.

[0023] The counter substrate 200 is formed with color filters at portions facing the pixel matrix circuits, and the color filters are formed with a transparent conductive film such as ITO film over the entire glass substrate. The transparent conductive film is a counter electrode facing the pixel electrode 111 of the pixel matrix circuit 101. An electric field produced between the pixel electrode 111 and the counter electrode drives the liquid crystal material.

[0024] The active matrix substrate has IC chips 131, 132 at the FPC 130 mounting surface. These IC chips are formed with a video signal processing circuit, a timing pulse generation circuit, a correction circuit, a memory circuit, a calculation circuit and others. Although two IC chips are shown in Figure 3, it is possible to use one IC chip or three or more IC chips.

[0025] In operating the liquid crystal display 21, the three-color LED lamps 13R, 13G, 13B of the LED light source 12 are illuminated. The red, green and blue rays emitted from the respective LED lamps enter the scatterplate 11 where they are scattered and mixed to form white rays LW that go out from the entire surface of the scatterplate 11. The white rays LW illuminate the whole back of the transmission type liquid crystal panel 10.

[0026] The white rays LW entering the transmission type liquid crystal panel 10 are modified according to the orientation of the liquid crystal material and pass through the color filters of the counter substrate. The PC user can recognize the transmitted light LT from the liquid crystal panel 10 as a color image.

Embodiment 2:

[0027] In the embodiment 1, color filters are used to produce color images, and three-color LED lamps 13R, 13G, 13B are illuminated simultaneously to produce white light. In this embodiment 2, color images are made without using color filters.

[0028] One frame of a color image is divided into three sub-frames. Red, blue and green image data are successively written into the pixel electrodes in the active matrix substrate. Then, in synchronism with the writing of red, blue and green image data, the LED lamps 13R, 13B, 13G are controlled to be turned on. That is, while

[0046] The LED arrays 90R, 90G, 90B can be turned on independently. At the timing that red, green and blue image data are written into the pixel electrodes, the corresponding color LED arrays can be turned on.

Embodiment 5:

[0047] The CMOS circuits and pixel matrix circuits formed according to the invention can be used on a variety of electro-optical devices (active matrix type liquid crystal displays). That is, this invention can be applied to all electronic devices incorporating these direct-viewing type liquid crystal panels.

[0048] Such electronic devices include video cameras, digital cameras, head mounted displays (goggle type displays), car navigation equipment, personal computers and mobile information terminals (mobile computers, cellular phones or electronic books). Such examples are shown in Figures 7(A) to 7(F).

[0049] Figure 7(A) shows a personal computer, which comprises a body 2001, an image input section 2002, a display 2003 and a keyboard 2004. This invention can be applied to the image input section 2002, the display 2003 and other signal control circuits.

[0050] Figure 7(B) shows a video camera, which comprises a body 2101, a display 2102, a voice input section 2103, operation switches 2104, a battery 2105 and a picture receiving section 2106. This invention can be applied to the display 2102, a voice input section 2103 and other signal control circuits.

[0051] Figure 7(C) shows a mobile computer, which comprises a body 2201, a camera section 2202, an image receiving section 2203, an operation switch 2204 and a display 2205. This invention can be applied to the display 2205 and other signal control circuits.

[0052] Figure 7(D) shows a goggle type display, which comprises a body 2301, a display 2302 and an arm section 2303. This invention can be applied to the display 2302 and other signal control circuits.

[0053] Figure 7(E) shows a player using a recording medium containing programs, which comprises a body 2401, a display 2402, a speaker 2403, a recording medium 2404, and an operation switch 2405. This device can use DVD (digital versatile disc), CD and others as a recording medium and allows the user to listen music, see movie and perform games and Internet. This invention can be applied to the display 2402 and other signal control circuit.

[0054] Figure 7(F) shows a digital camera, which comprises a body 2501, a display 2502, an eyepiece 2503, operation switches 2504 and an image receiving section (not shown). This invention can be applied to the display 2502 and other signal control circuits.

[0055] As described above, the range of application of this invention is very wide, including electronic devices in various fields which incorporate the direct-viewing type liquid crystal display. These electronic devices can be implemented by using any combination of the above

embodiments 1 to 4.

[0056] The use of the LEDs as an illuminating light source for the liquid crystal panel can eliminate the drawbacks of a backlight using a conventional cold cathode tube, such as high power consumption and short life of the light source, and offer reduced power consumption and longer life.

Claims

1. An electronic device incorporating a liquid crystal display which has an illuminating light source for a liquid crystal panel of the liquid crystal display; the illuminating light source comprising:

3-color light emitting diodes for producing three primary colors for additive color mixing; and means for mixing rays from the 3-color light emitting diodes to produce white light.

2. A device according to claim 1 wherein the electronic device is a video camera, a digital camera, a head mounted display, a car navigation equipment, a personal computer, a mobile computer, a cellular phone or an electronic book.

3. An electronic device incorporating a liquid crystal display which has an illuminating device for a liquid crystal panel of the liquid crystal display; the illuminating device comprising:

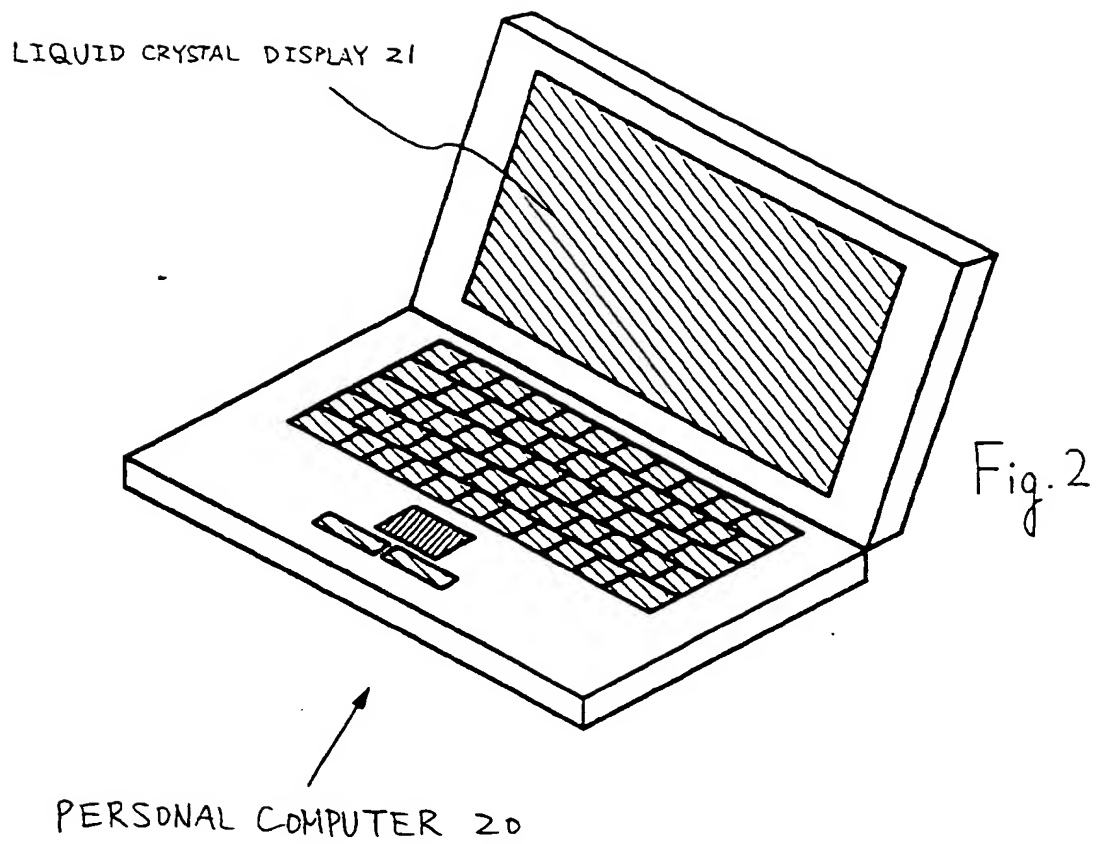
3-color light emitting diodes for producing three primary colors for additive color mixing; and a scatterplate for scattering rays from the 3-color light emitting diodes to produce white light.

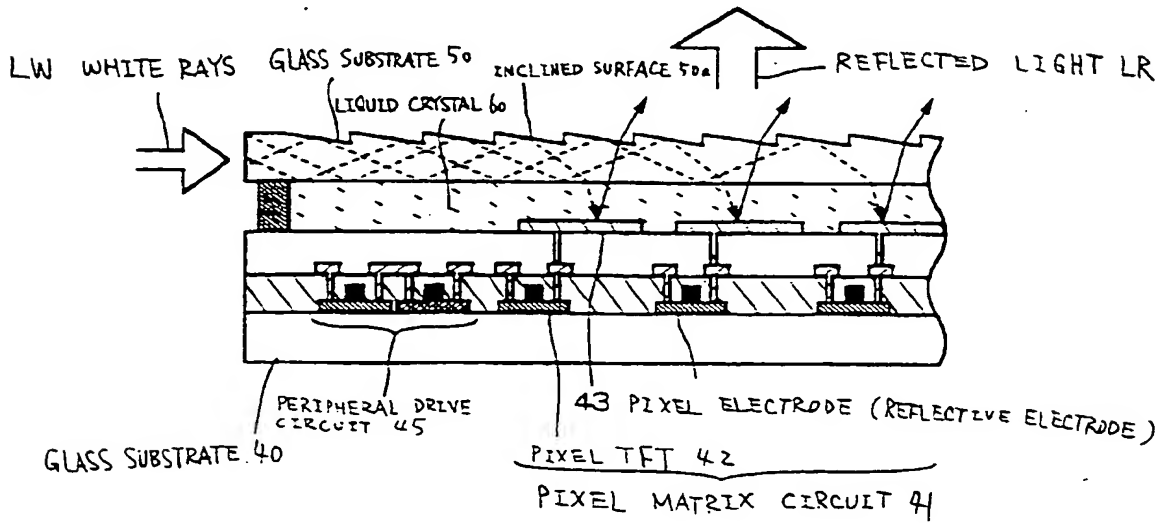
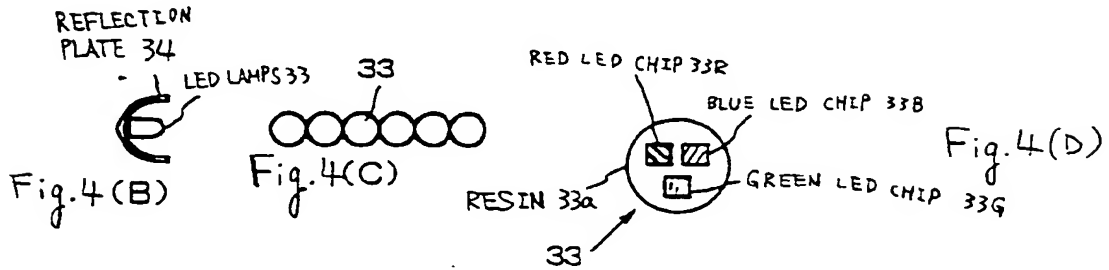
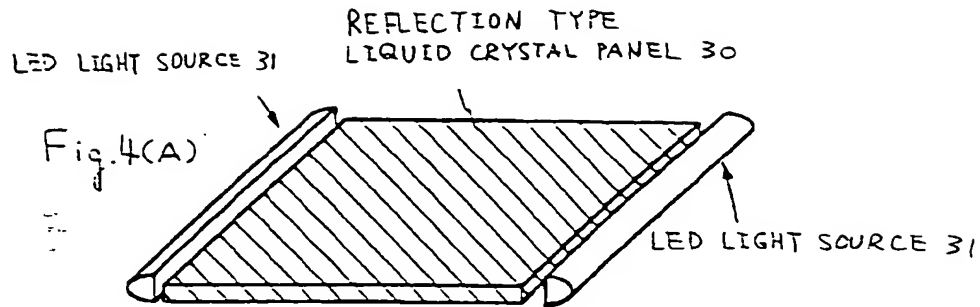
4. A device according to claim 3 wherein the electronic device is a video camera, a digital camera, a head mounted display, a car navigation equipment, a personal computer, a mobile computer, a cellular phone or an electronic book.

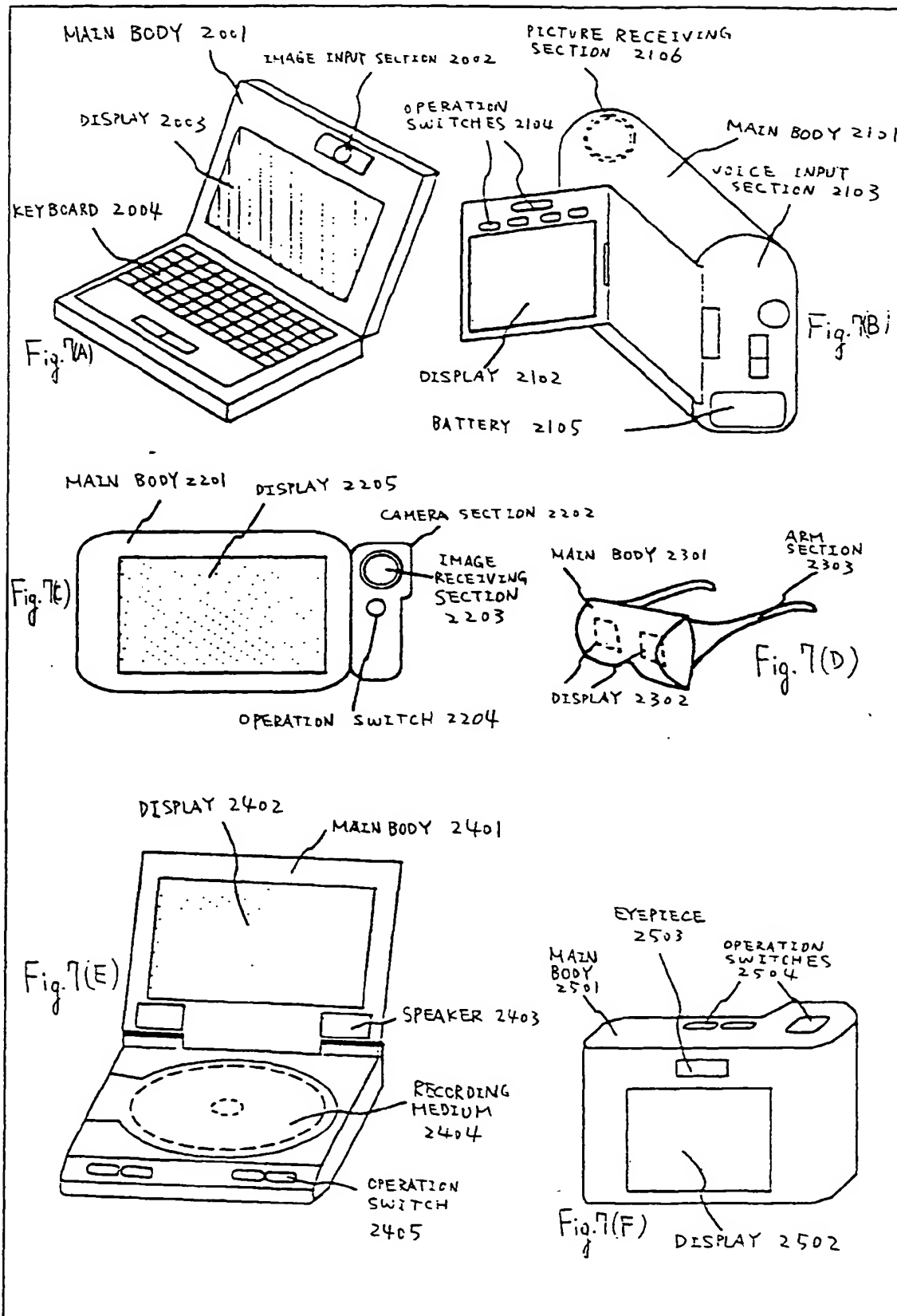
5. An electronic device incorporating a liquid crystal display comprising:

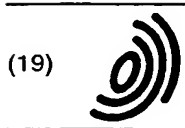
3-color light emitting diodes for producing three primary colors for additive color mixing in order to illuminate a liquid crystal panel of the liquid crystal display; and control means for controlling the turn-on of the 3-color light emitting diodes.

6. A device according to claim 5 wherein the electronic device is a video camera, a digital camera, a head mounted display, a car navigation equipment, a personal computer, a mobile computer, a cellular phone or an electronic book.









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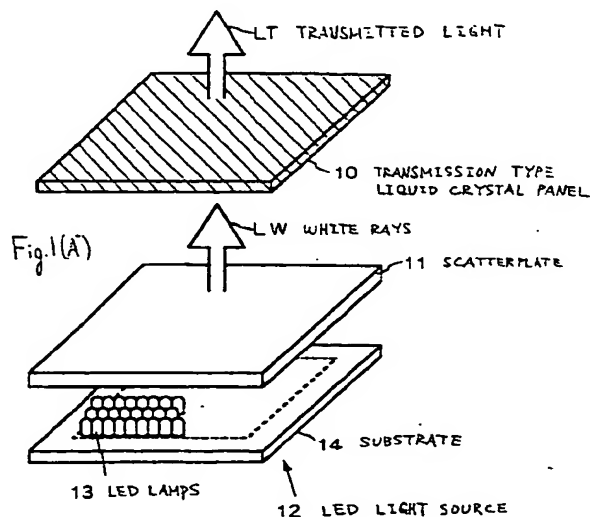
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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EP 99 11 7293

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